

On the Forefront

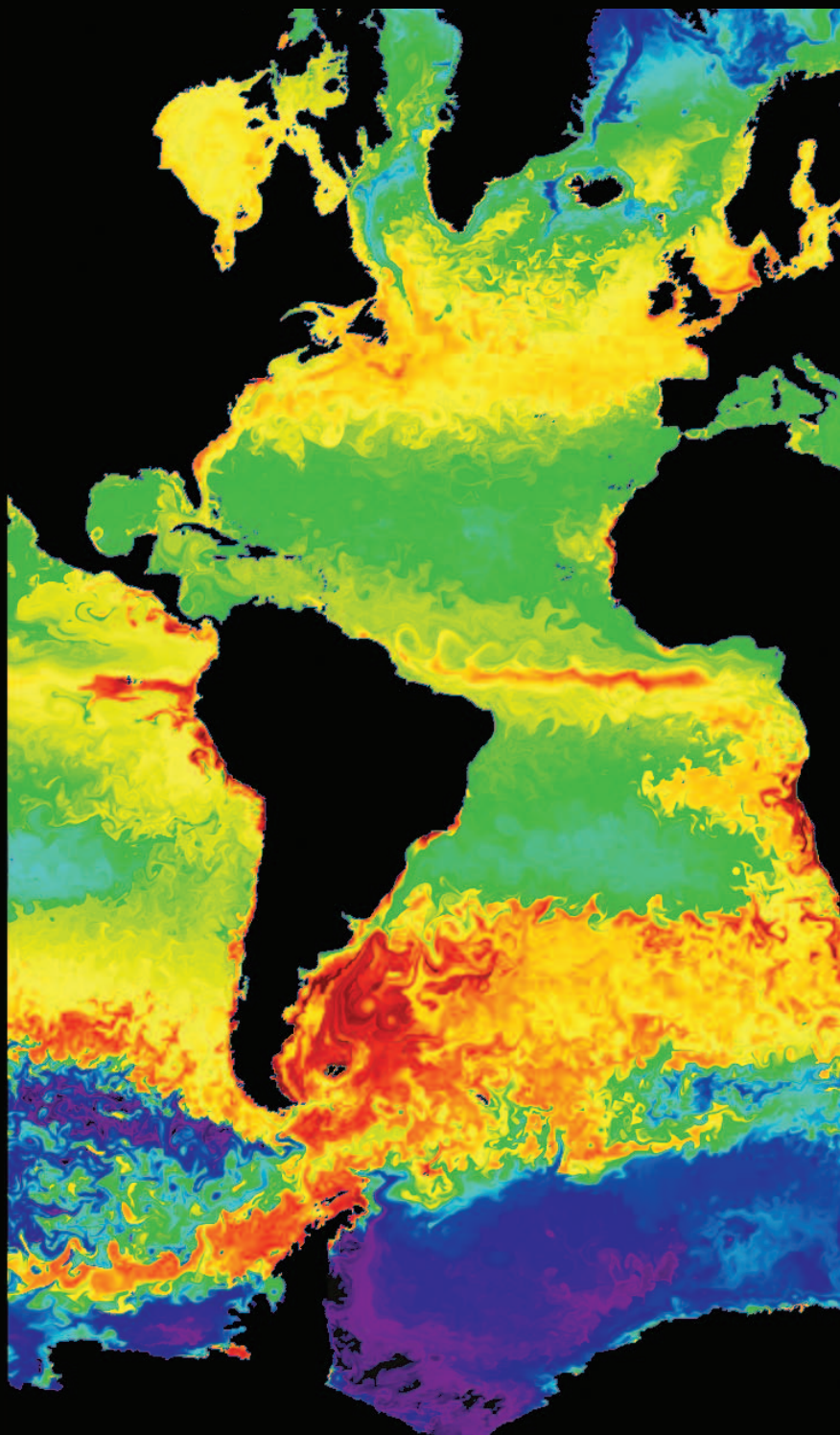
Modeling the distribution of oceanic phytoplankton

The sunlit upper layers of the world's oceans are home to an enormous variety of microscopic organisms that create their own food through photosynthesis—the process wherein sunlight powers the synthesis of simple carbohydrates from carbon dioxide and water. The organisms, known collectively as phytoplankton, are at the base of the aquatic food web and are crucial for sustaining oceanic life. When they excrete, die, or are consumed, some of their carbon sinks to the deep ocean, the net effect of which is known as the “biological pump”: marine sequestration of atmospheric carbon dioxide. Phytoplankton are also responsible for generating a large fraction of the Earth's gaseous oxygen (a byproduct of photosynthesis) and are, therefore, critical for sustaining human lives as well.

Scientists are able to monitor the global distribution of phytoplankton because the creatures change the optical properties of the water they inhabit. Chlorophyll and other pigments contained in the phytoplankton absorb the sunlight needed for photosynthesis, leaving less light to be reflected from the water's surface. Using satellites to measure the reflected light in several color bands, scientists can estimate the abundance of chlorophyll (phytoplankton) in the water.

The Climate, Ocean, and Sea Ice Modeling team at Los Alamos National Laboratory is on the forefront for developing numerical models used in ultra-high-resolution computer simulations. The graphic shown here is from a simulation of ocean chlorophyll concentration, a state-of-the-art enterprise combining a model of phytoplankton ecology and nutrient availability with a detailed ocean circulation model. Ocean chlorophyll data was used to verify that the simulations produce realistic phytoplankton distributions. No small undertaking, the simulation used approximately 18 months on Encanto, the high-performance, massively parallel, 170-teraflop computer at the New Mexico Computing Applications Center. Eventually, the team hopes to include these marine biogeochemical dynamics in a fully coupled global climate simulation and so assess the ocean's phytoplankton population in the face of global climate change.

The graphic shows the distribution for mid-November. A high concentration of chlorophyll (red) runs in a broad band around Antarctica due to the arrival of significant sunlight and the seasonal availability of nutrients that accumulated during the cold austral winter. High concentrations seen along the equator and along the western coasts of South America and Africa are due to an influx of nutrients brought to the ocean surface by upwelling currents.



helps to predict the sustainability of life on planet Earth.

